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SOIL-VEGETATION RELATIONSHIPS ON RANGELAND EXCLOSURES IN THE SALT WELLS PLANNING UNIT OF SOUTH WESTERN WYOMING

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SOIL-VEGETATION RELATIONSHIPS ON RANGELAND EXCLOSURES IN THE SALT WELLS PLANNING UNIT OF SOUTH WESTERN WYOMING[1]

BY

H. G. Fisser and D. C. Trueblood[2]

1980

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[2] Professor of Range Management and Graduate Research Assistant, Division of Range Management, University of Wyoming, Laramie, respectively,

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INTRODUCTION

The University of Wyoming and Bureau of Land Management entered into an agreement in 1979 to comprehensively describe some soil-vegetation relations of three planning unit areas in Western Wyoming. Rangeland exclosures were constructed within these areas in years past. Vegetation and site data have been obtained and recorded from these exclosures. Vegetation data included herbage production, cover, and composition values from as early as 1960; some obtained annually and some less often. Information such as moisture, temperature, and soil description were recorded at some exclosure sites for definitive expression of environmental conditions.

The geographic distribution of the exclosures provides great vegetational and edaphic diversity and obvious heterogeniety of environmental characteristics. The objectives of this program were (1) to inventory and characterize soils within rangeland exclosures and (2) to interrelate the soil characteristics with long term vegetation data.

The soil inventory and soil-vegetation relationship information from these exclosures can provide a valuable data base for use by the Bureau of Land Management to increase effectiveness of

decision processes as applied to rangeland resource management and use. In addition, these data will contribute to the better understanding of rangeland synecology and soil taxonomy on these sites; and, as well, will enhance information transfer to those concerned with use and management of natural resources.

DESCRIPTION OF THE STUDY AREA

This study was done on 9 exclosures in the Salt Wells Planning Unit which is located in the Red Desert of southwestern Wyoming (Table 1, Figure 1). This is an area of little precipitation, high summer temperatures and high evaporation with soils that tend to be alkaline and calcareous. Much of the area is dominated by shrubs, principally big sagebrush (Artemisia tridentata). For a detailed description of the environment at each exclosure, see the soil profile descriptions (Appendix A).

Table 1. Name, legal description, and county location of the 9 exclosures studied in the Salt Wells Planning Unit.

Exclosure	Location	County
Black Mountain	NE¼, SE¼, Sec. 30, T15N, R108W	Sweetwater
Boars Tusk	SE¼, SE¼, Sec. 24, T23N, R105W	Sweetwater
Cedar Mountain	SW¼, SW¼, Sec. 27, T14N, R110W	Sweetwater
Cumberland #1	SE¼, SE¼, Sec. 34, T18N, R117W	Uinta
Cumberland #2	Sec. 7, T19N, R118W	Lincoln
Cumberland #3	Sec. 32, T21N, R119W	Lincoln
Cumberland #4	SW¼, Sec. 22, T18N, R117W	Uinta
Farson	SE¼, NE¼, Sec. 8, T25N, R106W	Sweetwater
Radio Tower	SE¼, NE¼, Sec. 22, T19N, R103W	Sweetwater

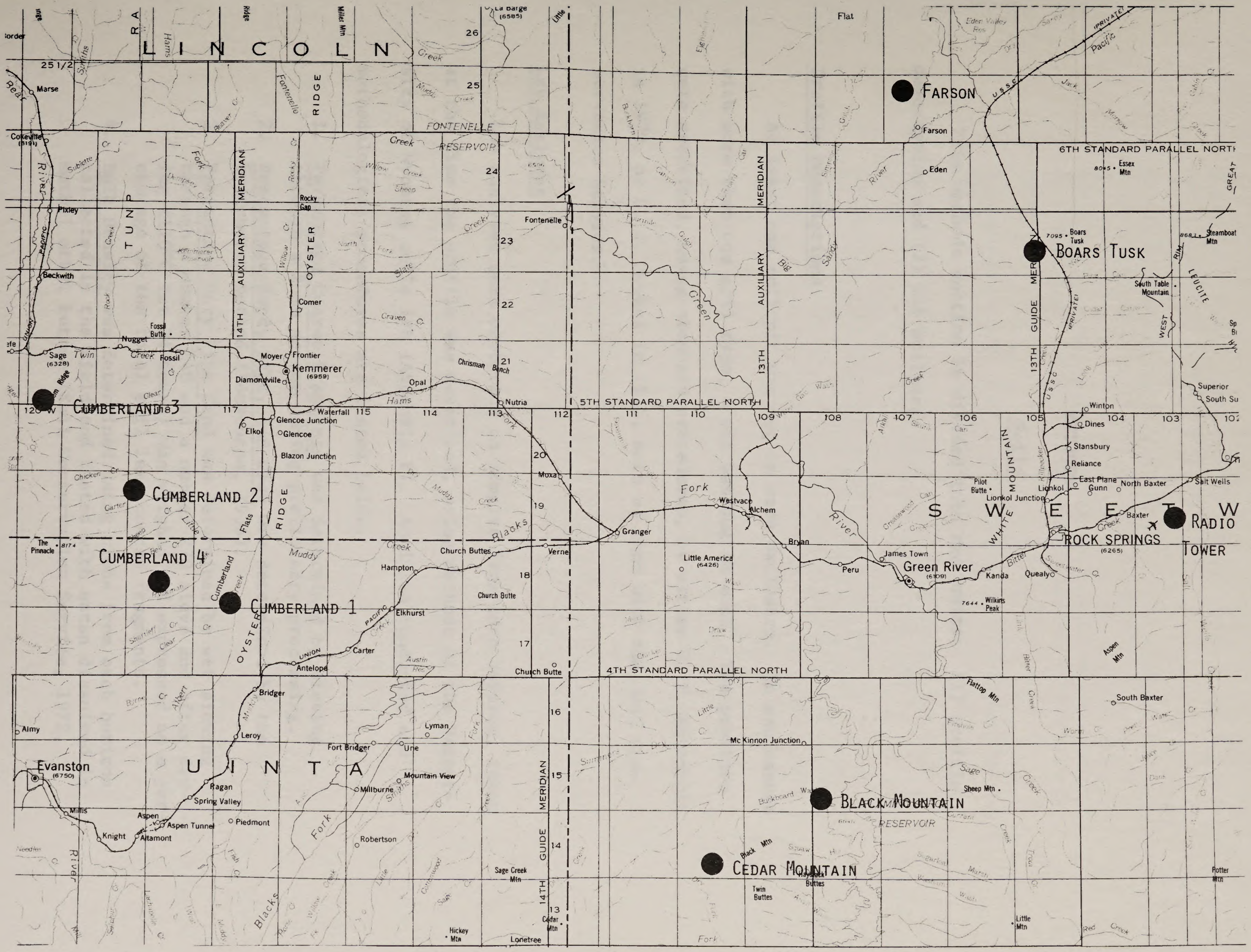
LINCOLN
FARSON
Farson
Eden
Flat
Eden Valley Res
6TH STANDARD PARALLEL NORTH
Essex Mtn
FONTENELLE RESERVOIR
Fontenelle
BOARS TUSK
Boars Tusk
Steamboat Mtn
South Table Mountain
LEUCITE RIM
Cokeville
Marse
Pixley
Beckwith
Sage
Nugget
Fossil Butte
Fossil
Frontier
Moyer
Kemmerer
Diamondville
Comer
Opal
Nutria
Chrisman Bench
OYSTER RIDGE
14TH AUXILIARY MERIDIAN
13TH AUXILIARY MERIDIAN
13TH GUIDE MERIDIAN
14TH GUIDE MERIDIAN
5TH STANDARD PARALLEL NORTH
4TH STANDARD PARALLEL NORTH
CUMBERLAND 3
CUMBERLAND 2
CUMBERLAND 4
CUMBERLAND 1
Waterfall
Glencoe Junction
Glencoe
Elkol
Blazon Junction
Moxa
Granger
Westvaco
Alchem
Bryan
Little America
James Town
Peru
Green River
Kanda
Quealy
Wilkins Peak
Church Buttes
Verne
Hampton
Church Butte
Elkhurst
Carter
Antelope
The Pinnacle
Superior
South Superior
Winton
Dines
Stansbury
Reliance
Pilot Butte
Lionkol Junction
Lionkol
East Plane
Gunn
North Baxter
Salt Wells
Baxter
RADIO TOWER
ROCK SPRINGS
SWEETWATER
WHITE MOUNTAIN
Aspen Mtn
Flattop Mtn
South Baxter
Bridger
Lyman
Almy
Leroy
Fort Bridger
Urie
Mc Kinnon Junction
Evanston
UINTA
Ragan
Mountain View
Millburne
Spring Valley
Aspen
Aspen Tunnel
Piedmont
Millis
Knight
Altamont
Robertson
BLACK MOUNTAIN
Sheep Mtn
RESERVOIR
CEDAR MOUNTAIN
Black Mtn
Twin Buttes
Haystack Buttes
Sage Creek Mtn
Hickey Mtn
Lonetree
Cedar Mtn
Little Mtn
Potter Mtn
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FIGURE 1. MAP OF THE STUDY AREA SHOWING LOCATIONS OF THE EXCLOSURES STUDIED. (ADAPTED FROM U.S. GEOLOGICAL SURVEY WYOMING BASE MAP).

METHODS

Soils

This methods section is divided into two units: (1) profile description and (2) lab analyses.

Profile Descriptions

At least one soil pit was dug in each exclosure. In exclosures with more than one soil type, a pit was dug in each. The profiles were described, using standard procedures, by either H. B. Ravenholt in 1979, or C. J. Fowkes in 1971; both of them with the Soil Conservation Service.

Lab Analyses

Lab analyses were performed on samples from each horizon, taken at the time the profile was described, using methods of the University of Wyoming soils lab (Appendix B). Analyses conducted and methodological procedures are listed below.

1. Percentage Coarse Fragments was determined by sieving through a 2 mm screen during preliminary processing.
2. Percentage Sand, Silt, and Clay was determined by the hydrometer method (Bouyoucos, 1936).
3. Percentage Very Fine Sand was determined by wet sieving through a number 140 and a number 270 sieve and after drying (110°C for 24 hours) was weighed and expressed as a percentage of the total soil less coarse fragments.
4. Bulk Density was determined using clods from each horizon collected in the field and coated with saran dissolved in methyl ethyl ketone (Soil Conservation Service, 1972,

modified). These clods were dried and weighed and the volume measured by displacement of water.

5. pH was determined using a glass electrode pH meter both on a saturated soil paste and on a 1:5 dilution.

6. Electrical Conductivity (EC) was determined on an extract of a soil paste using a conductivity bridge (U.S. Salinity Laboratory, 1954).

7. Percentage Organic Matter was determined by the Walkley and Black method 1934; (Black 1965).

8. Calcium Carbonate Equivalent was determined by the rapid titration method (U.S. Salinity Laboratory, 1954).

9. Percentage Soil Moisture Holding Capacity was determined in the laboratory at 1/3 and 15 bars on soil passed through a 2 mm sieve (fines) and on the saran coated clods (profile) using a pressure plate apparatus (Soil Conservation Service, 1972, modified).

10. Potential Available Moisture was determined in the laboratory, both for the profile (saran coated clods) and for the fines (<2 mm), as the difference between the percentage soil moisture at 1/3 and at 15 bars.

11. Effective Rooting Depth was determined as the depth to an in-penetrable layer (J. R. Stephens, personal communications). Actual rooting depth may be obtained from the profile descriptions.

Vegetation

All vegetation data was taken from the annual progress reports of an on-going cooperative research project with the Bureau of Land Management (Fisser, et. al. 1962-1978) and from research files at the University of Wyoming, Division of Range Management. Refer to these reports for detailed discussion of the methods used. The vegetation data is presented as long term means for cover and production for shrubs, perennial grasses, annual grasses, perennial forbs, annual forbs, and total (Appendices C and D).

[illegible]. These clods were dried and weighed and the volume measured by displacement of water.

5. pH was determined using a glass electrode pH meter both on a saturated soil paste and on a 1:5 dilution.

6. Electrical Conductivity (EC) was determined on an extract of a soil paste using a conductivity bridge (U.S. Salinity Laboratory, 1954).

7. Percentage Organic Matter was determined by the Walkley and Black method (Peech et al. 1947).

8. Calcium Carbonate Equivalent was determined by the rapid titration method (U.S. Salinity Laboratory, 1954).

9. Percentage Soil Moisture Holding Capacity was determined in the laboratory at 1/3 and 15 bars on soil passed through a 2 mm sieve (fines) and on the water stable clods (profile) using a pressure plate apparatus (Soil Conservation Service, 1972, unpublished).

10. Potential available moisture was determined in the laboratory, both for the profile (water-stable clods) and for the fines (<2 mm), as the difference between the percentage soil moisture at 1/3 and at 15 bars.

11. Effective Rooting Depth was determined as the depth to an impermeable layer (J. A. Rodgers, personal communication). Actual rooting depth may be obtained from the profile descriptions.

Vegetation

All vegetation data was taken from the annual progress reports of an ongoing cooperative research project with the Bureau of Land Management (Gibbens, et al. 1962-1970) and from research files at the University of Wyoming, Division of Range Management. Refer to these reports for detailed discussion of the methods used. The vegetation data is presented as long term means for cover and production for shrubs, perennial grasses, annual grasses, perennial forbs, annual forbs, and total (Appendices C and D).

RESULTS

In discussing results, the soils and vegetation are addressed separately and then combined for discussion of soil-vegetation relationships. Interpretive evaluation of soil and vegetation relations have been developed by observation at the study site of natural conditions and by subjective study of apparent trends exhibited by the data (vegetative and edaphic).

Soils

For the 9 exclosures there are 11 profile descriptions. Each of the profile descriptions represent a "study site". For those exclosures in which there is only one soil type, the study site and profile descriptions are identified by the exclosure name. For those exclosures including more than one soil type, the study sites and profile descriptions are differentiated by the exclosure name plus some identifying characteristic. This differentiating characteristic may be a description of the position of the site on a topographic gradient within the exclosure or of the dominant vegetation. When a description of the vegetation is used, a code for a dominant and differentiating species follows the exclosure name. These species codes are formed by combining the first two letters of the genus name with the first two letters of the species name (Table 2). Whatever method is used for differentiation, all study sites within an exclosure are identified by the same method, and the study site is identified by the same name throughout this report.

Table 2. List of code acronyms and corresponding genus and species with which specific study sites were identified at multiple type exclosures

Species Code	Name
ARSP	Artemisia spinescens
ARTR	Artemisia tridentata

Table 3. Taxonomic soil orders, sub-orders, and great groups at the 11 study sites of the 9 exclosure locations in the Salt Wells Planning Unit.

Study Site	Order	Sub-order	Great Group
Black Mountain	Aridisol	Orthid	Calciorthid
Boars Tusk (Ridge)	Entisol	Psamment	Torripsamment
Boars Tusk (Swale)	Entisol	Fluvent	Torrifluvent
Cedar Mountain (ARSP)	Aridisol	Orthid	Calciorthid
Cedar Mountain (ARTR)	Aridisol	Orthid	Calciorthid
Cumberland #1	Entisol	Orthent	Torriorthent
Cumberland #2	Entisol	Orthent	Torriorthent
Cumberland #3	Mollisol	Boroll	Calciboroll
Cumberland #4	Entisol	Orthent	Torriorthent
Farson	Aridisol	Argid	Haplargid
Radio Tower	Aridisol	Orthid	Camborthid

Table 4. Distribution of the study sites among the 3 soil orders and suborders present. 6

Order	Sub-order	Number of Study Sites	
Aridisol		5	
	Argid		1
	Orthid		4
Entisol		5	
	Fluvent		1
	Orthent		3
	Psamment		1
Mollisol	Boroll	1	

The soil at each site was classified according to the new comprehensive classification system (Soil Survey Staff, 1975) (Table 3). The distribution of the soils is as might be expected when related to the semi-arid temperate climate of the area (Table 4). Nearly all of the soils are in the orders Aridisol and Entisol. A dry climate determines the order Aridisol and may also severely restrict soil development thus producing Entisols. It should also be noted that the one soil classified in an order other than Aridisol and Entisol (Mollisol, Cumberland exclosure #3) does intergrade to the order Aridisol (Aridic Calciboroll) thus indicating that characteristics of the Aridisol order are present.

Most of the sub-orders and great groups present are characterized by the dry conditions, soil texture, and/or high calcium content. The sub-order not distinguished by these characteristics (Boroll) is characterized by the influence of the low mean annual temperature upon soil development.

Comparisons of soil chemical properties are made throughout this report using a single numerical value for each property at each study site. Each value represents the mean for all horizons within the rooting depth at a specific study site. The chemical properties of the soils vary widely (Table 5).

Ten soil series were found within the 9 exclosures, but only one occurred at more than one study site. This diversity of soil series represents important physical and chemical variations that is evaluated in greater detail in subsequent portions of this report. The only soil series found at multiple sites is the Elkol series which is found at two sites, Cumberland #1 and Cumberland #4. The soil chemical properties at these sites are very similar.

Table 5. Ranges of soil chemical properties studied.[1]

Chemical Property	High	Low
Percent Coarse (<2mm)	21	0
" Sand	84	22
" Silt	48	12
" Clay	34	4
" Very Fine Sand	23.3	9.7
Bulk Density	1.52	1.24
pH paste	8.7	7.5
" 1:1	9.4	8.2
Electrical Conductivity (mmho)	3.9	.5
Percent Organic Matter	8.3	1.6
Percent Calcium Carbonate	42.5	1.8
Percent Soil Moisture Holding Capacity		
Profile 1/3 bar	20.83	8.48
15 bar	12.97	5.26
Available	8.29	2.96
Fines 1/3 bar	31.57	7.92
15 bar	17.81	4.15
Available	15.40	3.77

---

[1] Each value represents the mean of all horizons within the rooting depth at a specific study site.

Vegetation

Of the 11 study sites, one (Boars Tusk-Ridgetop position) has no specific vegetation data. On all other study sites, data for dominant species determination (Table 6) and cover (Appendix C) have been obtained. Herbage production data are available from five sites. The vegetative parameters studied were vegetation type, percent cover, and annual production and will be discussed separately.

Vegetation Type

Sixty percent (6 sites) of the study sites are classified in the sagebrush vegetation type (Table 7). The remainder of the study sites are classified into four other types (one site per type). This seems to follow the general distribution of vegetation in the study area. It is also interesting to note that Agropyron smithii is the dominant understory species in all but one sagebrush site and is the dominant or co-dominant in 70 percent of all sites.

Vegetation Cover

The saltbush type appears to have a much lower total cover than other types (Table 8), even lower than the range of values for the sagebrush type. The bud sagewort type also appears to have a lower total cover than other types, but the total cover value for the bud sagewort type is within the range for the sagebrush type. Both the greasewood, mixed shrub and sagebrush types seem to have total cover values that are similar. The understory cover values for all types except the sagebrush type are also quite similar. The sagebrush type has a mean understory cover value much larger than those

Table 6. Dominant overstory and understory species at the 11 study sites of the 9 exclosure locations in the Salt Wells Planning Unit

Study Site	Dominant Overstory Species	Dominant Understory Species
Black Mountain	Artemisia tridentata	Agropyron smithii
Boars Tusk (Ridge)	*	*
Boars Tusk (Swale)	Artemisia tridentata	Agropyron smithii
Cedar Mountain (ARSP)	Artemisia spinescens	Sitanion hystrix
Cedar Mountain (ARTR)	Artemisia tridentata	Oryzopsis hymenoides
Cumberland #1	Sarcobatus vermiculatus	Agropyron smithii
Cumberland #2	Artemisia nova	Agropyron smithii
Cumberland #3	Artemisia tridentata	Agropyron smithii
Cumberland #4	Atriplex gardneri	Sitanion hystrix
Farson	Artemisia tridentata	Agropyron smithii
Radio Tower	Artemisia tridentata/ Atriplex gardneri	Agropyron spp.

*--No Data Available

Table 7. Vegetation types of the 11 study sites at the 9 exclosure locations in the Salt Wells Planning Unit

Study Site	Vegetation Type
Black Mountain	Sagebrush
Boars Tusk (Ridge)	*
Boars Tusk (Swale)	Sagebrush
Cedar Mountain (ARSP)	Bud Sagewort
Cedar Mountain (ARTR)	Sagebrush
Cumberland #1	Greasewood
Cumberland #2	Sagebrush
Cumberland #3	Sagebrush
Cumberland #4	Saltbush
Radio Tower	Sagebrush
Farson	Mixed Shrub

*--No Data Available

Table 8. Ranges[1] and means for total and understory vegetative cover for the five vegetation types at the nine exclosures studied.

Vegetation Type	Percent Cover					
	Total			Understory		
	High	Low	Mean	High	Low	Mean
Sagebrush	27.6	15.6	21.4	10.0	.9	7.0
Mixed Shrub			23.5			2.8
Greasewood			19.2			2.6
Bud sagewort			16.7			3.2
Saltbush			13.0			3.3

[1] Open data entries represent types with only one site.

Table 9. Ranges[1] and means for total and understory annual production for the three vegetation types at five exclosures studied.

Vegetation Type	Annual Production (lbs/acre)					
	Total			Understory		
	High	Low	Mean	High	Low	Mean
Sagebrush	726	415	586	393	124	263
Greasewood			566			219
Saltbush			295			120

[1] Open data entries represent types with only one site.

Table 10. Vegetation data for the two study sites at which the Elkol soil series occurs.

Vegetation Parameter	Study Sites	
	Cumberland #3	Cumberland #4
Vegetation Type	Greasewood	Saltbush
Dominat Species		
Overstory	Sarcobatus vermiculatus	Atriplex gardneri
Understory	Agropyron smithii	Sitanion hystrix
Percent Cover		
Total	19.2	13.0
Understory	2.6	3.3
Annual Production (lbs/acre)		
Total	566	295
Understory	219	120

for other types, but the range of values overlaps the values for all types.

Vegetation Production

Of the five vegetation types studied, production data is available on only three (5 study sites) (Table 9). The sagebrush and greasewood types have both total and understory production values that are similar, but, for both parameters, the production values for the saltbush type are much lower.

Elkol Soil Series at Multiple Sites

The vegetation parameters for the two study sites at which the Elkol soil series occurs are quite different in almost all respects (Table 10). The sites are classified in different vegetation types with different dominant species for both overstory and understory, production values are different by nearly a factor of 2, and total percent cover values are very different. The only parameter for which the sites are similar is understory cover.

Soil-Vegetation Relationships

The soil-vegetation relationships section is separated into sub-sections, each of which discuss the relationship of the vegetation parameters; vegetation type, percent cover, and annual production; with a single soil property. Vegetation production and cover comparisons are discussed only within the sagebrush type because it is the only type occurring at multiple study sites. Soil-vegetation relationships are not considered for the Elkol soil series as it appears at multiple sites because relationships are impossible to ascertain using only two study sites. In addition, the relationships between production within the sagebrush type should be carefully considered because information from only three sites is used.

Soil Type

The vegetation types are well distributed among the soil orders (Table 11). In addition, there does not seem to be any relationship between soil type and percent cover or annual production (Table 12). The one exception is that the production for the site at which the soil is classified in the order Mollisol is higher than the production for all other sites. This is consistent with the classification because the order Mollisol requires a mollic surface horizon which requires a high level of organic matter.

Table 11. Distribution of the vegetation types among the soil orders and sub-orders occurring at the 9 exclosure locations.

Order	Sub-order	Vegetation Types				
		Sagebrush	Bud Sagewort	Greasewood	Saltbush	Mixed Shrub
Aridisol		3	1			1
	Argid	1				
	Orthid	2	1			1
Entisol		2		1	1	
	Fluvent	1				
	Orthent	1		1	1	
Mollisol	Boroll	1				

Table 12. Ranges[1] and means for total percent cover and total annual production for each soil order and sub-order occurring at the 9 exclosure locations.

Order	Sub-Order	Total Percent Cover			Total Annual Production		
		High	Low	Mean	High	Low	Mean
Aridisol		27.6	15.6	20.3			415
	Argid			15.6			415
	Orthid	27.6	16.7	21.5			*
Entisol		24.7	13.0	18.9	617	295	493
	Fluvent			24.7			*
	Orthent	19.2	13.0	16.9	617	295	493
Mollisol	Boroll			23.8			726

1--Open data entries represent types with only one site.

*--No data available

Rooting Depth

The effective rooting depth relationship to vegetation type, percent cover, or annual production for the sites observed exhibited no apparent trend.

Coarse Fragments

The data indicated no apparent relationship between the percentage of coarse fragments and vegetation type, percent cover, or annual production for the sites studied.

Texture

There appears to be an inverse relationship between the percentage of sand and total percent cover within the sagebrush type (Table 13). There also appears to be a direct relationship between the percentage of silt and total percent cover within the sagebrush type (Table 14). Both relationships are complicated by one site, Cumberland #2. This complication may be explained by a difference in dominant species (Table 6); Cumberland #2 is dominated by *Artemisia nova* while all other sites in the sagebrush type are dominated by *Artemisia tridentata*. The percentages of clay or very fine sand do not appear to be related to total percent cover for the sites studied.

The percentage of clay seems to be related to total annual production within the sagebrush type (Table 15). There does not appear to be any relationship between the percentages of sand, silt, or very fine sand and total annual production; nor does there appear to be any relationship between any of the textural parameters (percentages of sand, silt, clay, and very fine sand) and vegetation type for the sites studied.

Table 13. Comparison of the percentage of sand with percent vegetative cover within the sagebrush vegetation type.

Study Site	Sand (%)	Vegetative Cover (%)
Farson	73	15.6
Black Mountain	65	18.3
Cumberland #3	42	23.8
Boars Tusk (Swale)	41	24.7
Cedar Mountain (ARTR)	40	27.6
Cumberland #2	37	18.5

Table 14. Comparison of the percentage of silt with percent vegetative cover within the sagebrush vegetation type.

Study Site	Silt (%)	Vegetative Cover (%)
Cedar Mountain (ARTR)	42	27.6
Cumberland #2	41	18.5
Boars Tusk (Swale)	38	24.7
Cumberland #3	35	23.8
Black Mountain	23	18.3
Farson	13	15.6

Table 15. Comparison of the percentage of clay with total production within the sagebrush vegetation type.

Study Site	Clay (%)	Total Production (lbs/acre)
Cumberland #3	24	726
Cumberland #2	22	617
Farson	15	415

Table 16. Comparison of organic matter content with total production within the sagebrush vegetation type.

Study Site	Organic Matter (%)	Total Production (lbs/acre)
Cumberland #3	8.3	726
Cumberland #2	4.2	617
Farson	2.1	415

pH

Neither the pH of a saturated paste, nor that of a 1:5 dilution appears to have any relationship with vegetation type, total percent cover, or total annual production for the sites studied.

Organic Matter

The percentage of organic matter in the soil appears to be related to total annual production in the sagebrush type (Table 16). This is to be expected because sites with higher production have more mulch which is eventually incorporated into the soil. The percentage of organic matter in the soil does not seem to be related to vegetation type or total percent cover for the sites studied.

Calcium Carbonate

There does not seem to be any relationship between the percentage of calcium carbonate in the soil and vegetation type, total percent cover, or total annual production for the sites studied.

Electrical Conductivity

The electrical conductivity of a soil paste extract appears to be related to vegetation type (Table 17). The conductivity for the saltbush type is much higher than that for other types and is also higher than the range of values for the sagebrush type. All other types have conductivity values that are similar. There does not appear to be any relationship between electrical conductivity and either total percent cover or total annual production for the sites studied.

Table 17. Comparison of the ranges[1] and means of the electrical conductivity of a soil paste extract among the vegetation types.

Vegetation Type	EC (mmhos)		
	High	Low	Mean
Sagebrush	3.4	.4	1.0
Saltbush			3.9
Mixed shrub			.8
Bud sagewort			.7
Greasewood			.7

1--Open data entries represent types with only one site.

Table 18. Comparison of the ranges[1] and means of bulk density among the vegetation types.

Vegetation Type	Bulk Density (g/cc)		
	High	Low	Mean
Sagebrush	1.52	1.24	1.32
Saltbush			1.45
Mixed shrub			1.45
Greasewood			1.45
Bud sagewort			1.48

1--Open data entries represent types with only one site.

Table 19. Comparison of bulk density with total production within the sagebrush vegetation type.

Study Site	Bulk Density (g/cc)	Total Production (lbs/acre)
Farson	1.52	415
Cumberland #2	1.28	617
Cumberland #3	1.24	726

Bulk Density

The bulk density of the soil seems to be related to the vegetation type growing on it (Table 18). The mean bulk density for the sagebrush type is lower than the values for other types which are similar. The bulk density values for other types are within the range for the sagebrush type but are very high within that range.

Bulk density also appears to be inversely related to total annual production (Table 19), but not to total percent cover.

Soil Moisture Relationships in Profile (Saran coated clods)

Neither the percent soil moisture in the profile at 1/3 bar or 15 bars, nor the potential available moisture in the profile appear to have any relationship with vegetation type, total percent cover, or total annual production for the sites studied.

Soil Moisture Relationships in Fines

Neither the percent soil moisture in the fines at 1/3 bar or 15 bars, nor the potential available moisture in the fines appear to have any relationship with vegetation type, total percent cover, or total annual production for the sites studied.

SUMMARY

Nine exclosure locations in the Salt Wells Planning Unit of southwestern Wyoming were studied to evaluate relationships between soils and vegetation under rangeland conditions. Specific objectives were:

1) To inventory and characterize soils within rangeland exclosures.
2) To interrelate the soil characteristics with long term vegetation data.

The soils in this area show a low degree of development due to the arid conditions. Because of this, the soils at all but one of the 11 study sites are classified into the orders Aridisol (characterized by a dry climate) and Entisol (characterized by a lack of development). Of the 11 study sites, however, the soils at only two were classified in the same soil series which provides great variation in both chemical and physical parameters.

At sixty percent of the study sites, the vegetation is dominated by sagebrush. The remainder of the study sites are dominated by other species of drought tolerant shrubs.

The following are the relationships between soil and vegetation parameters that appear to be important:

1) The percentage of sand appears to be inversely related to total percent cover in the sagebrush type.
2) The percentage of silt appears to be directly related to total percent cover in the sagebrush type.

3) The percentage of clay appears to be directly related to total annual production in the sagebrush type.

4) The organic matter content of the soil appears to be directly related to total annual production in the sagebrush type.

5) The electrical conductivity of a soil paste extract appears to be related to the vegetation types.

6) The bulk density appears to be related to the vegetation types.

7) The bulk density appears to be inversely related to total annual production in the sagebrush type.

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APPENDIX A

SOIL PROFILE DESCRIPTIONS

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TEAGULF (Black Mountain Exclosure)
Soil Family: Typic Calciorthid; coarse-loamy, mixed frigid
Location: Sweetwater County, Wyoming; NE¼, SE½, Section 30, T15N, R108W.
Climate: Mean annual precipitation for 17 years of record is 7.39 inches. Mean annual air temperature is about 44°F, mean summer air temperature is about 66°F, and the frost-free season is about 100 days.
Vegetation: Shadscale, Spiny hopsage, Indian ricegrass, Bluebunch wheatgrass.
Parent Material: Residuum
Topography: Gently sloping, slope-1 percent, aspect-south; elevation-6170 ft.
Physiography: Upland pediment
Drainage: Well drained
Groundwater: Deep
Erosion: Slight
Permeability: Moderately rapid
Sampled by: H. Ravenholt, D. Trueblood, and D. Rogers
Described by: H. Ravenholt, 6-28-79
(Colors are for dry soil unless otherwise noted)

A11 0 to 10 cm (0-4"); pale brown (10YR 6/3) fine sandy loam, brown (10YR 4/3) moist; moderate very fine granular structure; soft, very friable, slightly sticky, nonplastic; slightly effervescent; mildly alkaline (pH 7.8); many very fine and fine roots; abrupt wavy boundary.

A12 10 to 15 cm (4-6"); light gray (10YR 7/2) sandy loam; brown (10YR 4/3) moist; weak thin platy structure; soft, very friable, slightly sticky, nonplastic, strongly effervescent; moderately alkaline (pH 8.0); common very fine to medium roots; abrupt wavy boundary.

B2 6 to 30 cm (6-12"); yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/4) moist; weak very coarse prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky, nonplastic; strongly effervescent; strongly alkaline (pH 8.8); few very fine and fine roots; clear wavy boundary.

B3ca 30 to 63 cm (12-25"); light olive brown (2.5Y 5/4) sandy loam, olive brown (2.5Y 4/4) moist; weak very coarse prismatic structure; hard, friable, slightly sticky, slightly plastic; strongly effervescent; numerous lime specks and pockets; strongly alkaline (pH 9.0); few very fine and fine roots; clear wavy boundary.

C1ca 63 to 91 cm (25-36"); light yellowish brown (10YR 6/4) shaley sandy loam, yellowish brown (10YR 5/6) moist; massive; soft, very friable, slightly sticky nonplastic; violently effervescent; very strongly alkaline (pH 9.2); few very fine and fine roots; 60 percent soft sandstone fragments with thin lime crusts; gradual wavy boundary.

C2r 91 cm (36"); soft sandstone bedrock.

TEAGUE (Black Mountain Exclosure)
Soil Family: Typic Calciorthid; coarse-loamy, mixed frigid
Location: Sweetwater County, Wyoming; NE¼, SE¼, Section 30, T15N, R109W.
Climate: Mean annual precipitation for 11 years of record is 7.32 inches. Mean annual air temperature is about 40°F, mean summer air temperature is about 60°F, and the frost-free season is about 100 days.
Vegetation: Shadscale, spiny hopsage, Indian ricegrass, Bluebunch wheatgrass
Parent Material: Residuum
Topography: Gently sloping, [illegible] percent; aspect-south; elevation-[illegible] ft.
Physiography: Upland pediment
Drainage: Well drained
Groundwater: Deep
Erosion: Slight
Permeability: Moderately rapid
Examined by: M. Ravenholt, C. Trueblood, and D. Rogers
Described by: M. Ravenholt, 8-29-79
(Colors are for dry soil unless otherwise noted)

A11 0 to 12 cm (0-5"); pale brown (10YR 6/3) fine sandy loam, brown (10YR 4/3) moist; moderate thin fine granular structure; soft, very friable, slightly sticky, nonplastic; slightly effervescent; mildly alkaline (pH 7.4); many very fine and fine roots; abrupt wavy boundary.

A12 12 to 15 cm (5-6"); light gray (10YR 7/2) sandy loam, brown (10YR 5/3) moist; weak thin platy structure; soft, very friable, slightly sticky, nonplastic; moderately effervescent; moderately alkaline (pH 8.0); common very fine to medium roots; abrupt wavy boundary.

B2 15 to 32 cm (6-13"); yellowish brown (10YR 5/4) sandy loam, dark yellowish brown (10YR 4/4) moist; weak moderate prismatic structure parting to weak medium subangular blocky structure; soft, very friable, slightly sticky, nonplastic; strongly effervescent; moderately alkaline (pH 8.2); many very fine and fine roots; clear wavy boundary.

B3ca 32 to 55 cm (13-22"); light olive brown (2.5Y 5/4) sandy loam, olive brown (2.5Y 4/4) moist; weak very coarse prismatic structure; soft, friable, slightly sticky, nonplastic; strongly effervescent; numerous fine seams and nodules; strongly alkaline (pH 8.6); few very fine and fine roots; clear wavy boundary.

C1ca 55 to 91 cm (22-36"); light yellowish brown (10YR 6/4) sandy loam, yellowish brown (10YR 5/4) moist; massive; soft, very friable, slightly sticky, nonplastic; violently effervescent; very strongly alkaline (pH 9.2); few very fine and fine roots; 50 percent soft sandstone fragments with thin lime crusts; gradual wavy boundary.

Cr 91 cm (36"); soft sandstone bedrock.

KANDALY (P) loamy fine sand (Boars Tusk Exclosure, Ridgetop Position)
Soil Family: Typic Torripsamment; mixed, frigid
Location: Sweetwater County, Wyoming; SE$\frac{1}{4}$, SE$\frac{1}{4}$, section 24, T23N, R105W.
Climate: Mean annual precipitation for 13 years of record is 7.66 inches. Mean annual air temperature is about 44°F, mean summer air temperature is about 65°F, and the frost-free season is about 100 days.
Vegetation: Spiny hopsage, Indian ricegrass, Bottlebrush squirreltail.
Parent Material: Eolian
Topography: Choppy, slope-5 percent, aspect-south; elevation-6735 ft.
Physiography: Small sand dune
Groundwater: Deep
Sampled by: H. Ravenholt, D. Trueblood, and D. Rogers
Described by: H. Ravenholt, 6-29-79
(Colors are for dry soil unless otherwise noted)

A1 0 to 8 cm. (0 to 3 in.). Brown (10YR 5/3) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak medium platy structure; soft, very friable, nonsticky, nonplastic; slightly effervescent; ph 8.8; common very fine to coarse roots; clear wavy boundary.

C1 8 to 48 cm. (3 to 19 in.). Brown (10YR 5/3) loamy fine sand, dark grayish brown (10YR 4/2) moist; massive; soft, very friable, nonsticky, nonplastic; slightly effervescent; pH 8.6; few very fine roots; clear wavy boundary.

C2 48 to 91 cm. (19 to 36 in.). Brown (10YR 5/3) fine sandy loam, dark grayish brown (10YR 4.2) moist; massive; slightly hard, very friable, very slightly sticky, very slightly plastic; slightly indurated; slightly effervescent; pH 8.0; very small splotches of micellia; clear wavy boundary.

C3 91 to 150 cm. (36 to 60 in.). Brown (10YR 5/3) loamy fine sand, dark grayish brown (10YR 4/2) moist; single grain; loose; strongly effervescent; pH 8.6; few channels.

KANDALL (?) loamy fine sand (Boars Tusk Exclosure, Ridgetop Position)
Soil Family: Typic Torripsamments; mixed, frigid
Location: Sweetwater County, Wyoming, SE¼, SE¼, Section 24, T23N, R105W.
Climate: Mean annual precipitation for 13 years of record is 7.66 inches. Mean annual air temperature is about 44°F, mean summer air temperature is about 65°F, and the frost-free season is about 100 days.
Vegetation: Spiny hopsage, Indian ricegrass, Bottlebrush squirreltail.
Parent Material: Eolian
Topography: Choppy, slope-2 percent, [illegible], elevation-6,720 ft.
Physiography: Small sand dune
Groundwater: Deep
Described by: M. [illegible], D. [illegible], and D. Rogers
Classified by: M. [illegible], [illegible]
(Colors are for dry soil unless otherwise noted.)

A1 — 0 to 4 cm. (0 to 2 in.). Brown (10YR 5/3) loamy fine sand, dark grayish brown (10YR 4/2) moist; weak fine [illegible] structure; soft, very friable, nonsticky, nonplastic; slightly effervescent; pH 8.4; common very fine roots; clear wavy boundary.

C1 — 4 to 14 cm. (2 to 5½ in.). Brown (10YR 5/3) loamy fine sand, dark grayish brown (10YR 4/2) moist; massive; soft, very friable, nonsticky, nonplastic; slightly effervescent; pH 8.6; few very fine roots; clear wavy boundary.

C2 — 14 to 27 cm. (5½ to 11 in.). Brown [illegible] loamy fine sand, [illegible] (10YR 4/3) moist; massive; slightly hard, very friable, [illegible]; slightly effervescent; pH 8.8; [illegible]; clear [illegible] boundary.

C3 — 27 to 150 cm. (11 to 60 in.). Brown [illegible] loamy fine sand, [illegible] moist; single grain; loose; [illegible] effervescent; pH 8.8; few [illegible] roots.

DINES (P) (Boars Tusk Exclosure, Swale Position)
Soil Family: Typic Torrifluvent; fine-silty, mixed, calcareous, frigid
Location: Sweetwater County, Wyoming; SE¼, SE¼, section 24, T23N, R105W.
Climate: Mean annual precipitation for 13 years of record is 7.66 inches. Mean annual air temperature is about 44°F, mean summer air temperature is about 65°F, and the frost-free season is about 100 days.
Vegetation: Big sagebrush, Bluebunch wheatgrass, Bottlebrush squirreltail
Parent Material: Alluvium
Topography: Gently sloping, slope-1 to 2 percent, aspect-east; elevation-6735 ft.
Physiography: Bottom of draw
Drainage: Well drained
Groundwater: Deep
Erosion: Slight
Permeability: Moderate
Sampled by: H. Ravenholt, D. Trueblood, and D. Rogers
Described by: H. Ravenholt, 6-29-79
(Colors are for dry soil unless otherwise noted)

A11 0 to 8 cm (0-3"); light gray (10YR 7/2) silt loam, light olive brown (2.5Y 5/4) moist; weak medium platy structure parting to weak very fine granular; soft, very friable, slightly sticky, plastic; strongly effervescent; moderately alkaline; pH 8.0; many very fine to medium roots; clear wavy boundary.

A12 8 to 23 cm (3-9"); pale brown (10YR 6/3) loam, brown (10YR 4/3) moist; weak medium subangular structure; slightly hard, very friable, sticky, plastic; strongly effervescent; moderately alkaline; pH 8.0; many very fine to medium roots; clear wavy boundary.

C1 23 to 61 cm (9-24"); pale brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; weak medium subangular blocky structure; slightly hard, very friable, sticky, plastic; common very fine to medium roots; clear wavy boundary.

k 35 to 43 cm (14-17"); a krotovina of very gravelly loam, 40 percent gravel less than ¼ inch, other characteristics same as above horizon.

C2 61 to 71 cm (24-28"); pale brown (10YR 6/3) loam, brown (10YR 4/3) moist; massive; slightly hard, very friable, sticky, plastic; strongly effervescent; common very fine to medium roots; clear wavy boundary.

C3 70 to 150 cm (28-60"); pale brown (10YR 6/3) silty clay loam, brown (10YR 4/3) moist; massive; slightly hard, very friable, sticky, plastic; strongly effervescent; moderately alkaline; pH 8.0; few roots.

GARITA Taxadjunct (Cedar Mountain Exclosure, ARSP Type)
Soil Family: Typic Calciorthid; fine-loamy, mixed, frigid
Location: Sweetwater County, Wyoming; SW¼, SW¼, section 27, T14N, R110W.
Climate: Mean annual precipitation for 17 years of record is 8.12 inches. Mean annual air temperature is about 44°F, mean summer air temperature is about 65°F, and the frost-free season is about 100 days.
Vegetation: Gardner saltbush, Bud sagewort, Bottlebrush squirreltail, crested wheatgrass.
Parent Material: Alluvium
Topography: Nearly level, slope-0 to 1 percent; elevation-7000 ft.
Physiography: Old terrace remnant
Drainage: Well drained
Groundwater: Deep
Erosion: Slight
Permeability: Moderate
Sampled by: H. Ravenholt, D. Trueblood, and D. Rogers
Described by: H. Ravenholt, 6-28-79
(Colors are for dry soil unless otherwise noted)

A11 0 to 2 cm (0-1"); light brownish gray (10YR 6/2 loam, brown (10YR 4/3) moist; vesicular crust; soft, very friable, sticky, plastic; strongly effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary; 25 percent gravel on surface.

A12 2 to 8 cm (1-3"); brown (10YR 5/3) loam; brown (10YR 4/3) moist; moderate fine granular structure; soft, very friable, sticky, plastic; strongly effervescent; moderately alkaline (pH 8.0); many fine and medium roots; abrupt wavy boundary.

B 8 to 18 cm (3-7"); brown (10YR 5/3) loam; brown (10YR 4/3) moist; moderate fine prismatic structure parting to weak very fine subangular blocky; slightly hard, friable, sticky, plastic; strongly effervescent; moderately alkaline (pH 8.2); many fine and medium roots; clear wavy boundary.

B3 18 to 75 cm (7-30"); light yellowish brown (10YR 6/4) gravelly loam; yellowish brown (10YR 5/4) moist; moderate fine prismatic structure parting to weak very fine subangular blocky; slightly hard, friable, sticky, plastic; violently effervescent, desseminated lime and thin lime crusts on gravel; strongly alkaline (pH 8.8); common fine and medium roots; 20 percent gravel; gradual wavy boundary.

C1 76 to 117 cm (30-46"); pale brown (10YR 6/3) gravelly loam; dark yellowish brown (10YR 4/4) moist; massive; soft, friable, sticky, plastic; violently effervescent; moderately alkaline (pH 8.0); few very fine and fine roots, 20 percent gravel.

CAMBARGE (Cedar Mountain Exclosure, ARTR Type)
Soil Family: Typic Calciorthid; coarse-loamy, mixed, frigid
Location: Sweetwater County, Wyoming; SW¼, SW¼, section 27, T14N, R110W.
Climate: Mean annual precipitation for 17 years of record is 8.12 inches. Mean annual air temperature is about 44°F, mean summer air temperature is about 65°F, and the frost-free season is about 100 days.
Vegetation: Big sagebrush, Bluebunch wheatgrass
Parent Material: Alluvium
Topography: Nearly level, slope-0 to 1 percent; elevation-7000 ft.
Physiography: Old terrace remnant
Drainage: Well drained
Groundwater: Deep
Erosion: Slight
Permeability: Moderately rapid
Sampled by : H. Ravenholt, D. Trueblood, and D. Rogers
(Colors are for dry soil unless otherwise noted)

A11 0 to 2 cm (0-1"); light gray (10YR 7/2) loam; brown (10YR 4/3)moist; vesicular crust; slightly hard, very friable, slightly sticky, slightly plastic; strongly effervescent; moderately alkaline (pH 8.0); abrupt wavy boundary.

A12 2 to 8 cm (1-3"); brown (10YR 5/3) loam, brown (10YR 4/3) moist;moderate fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic, strongly effervescent; moderately alkaline (pH 8.0); common very fine to coarse roots; abrupt wavy boundary.

B 8 to 25 cm (3-10"); brown (10YR 5/3) loam, brown (10YR 4/3) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable slightly sticky, slightly plastic; strongly effervescent; moderately alkaline (pH 8.0); many very fine to coarse roots; clear wavy boundary.

C1ca 25 to 68 cm (10-27"); pinkish white (7.5YR 8/2) loam, pinkish gray (7.5YR 6/2) moist; massive; slightly hard, friable, slightly sticky, slightly plastic; violently effervescent; soft and slightly hard lime pockets; moderately alkaline (pH 8.4) common very fine to medium roots; clear wavy boundary.

IIC2ca 68 to 94 cm (27-37"); pinkish gray (7.5YR 7/2) very gravelly loamy sand, pinkish gray (7.5YR 6/2) moist; massive; loose; very slightly sticky, nonplastic; violently effervescent; lime crusts on gravel; moderately alkaline (pH 8.0); clear wavy boundary.

IIC3 94 to 127 cm (37-50"); same as above horizon except no lime crusts on gravel.

ELKOL silty clay (Cumberland Exclosure #1)
Soil Family: Ustic Torriorthent; fine, montmorillonitic, calcareous, frigid
Location: Uinta County, Wyoming; SE¼, SE¼, section 34, T18N, R117W.
Climate: Mean annual precipation for 13 years of record is 7.91 inches. Mean annual soil temperature is about 45°F and the frost-free season is about 100 days.
Vegetation: Greasewood, Big sagebrush, western wheatgrass
Parent Material: Fine textured, calcareous alluvium
Topography: Slope-0 to 10 percent; elevation-6500 to 7200 ft.
Physiography: Alluvial fan
Drainage: Moderately well drained
Described by: C. Fowkes, 1971
(Colors are for dry unless otherwise stated)

A11 (0-2"); light olive gray (5Y 6/2) silty clay, olive brown (2.5Y 4/3) moist; moderate fine granular structure; slightly hard, friable, very sticky, plastic; common medium and coarse roots; moderate micro, very fine, and fine pores; calcareous, strongly alkaline; pH 8.4 TB; clear wavy boundary.

A12 (2-5"); pale brown (5Y 6/3) silty clay, olive (5Y 4/3) moist; weak very fine platy structure; slightly hard, friable, very sticky, plastic; common medium and coarse roots; common micro, very fine, and fine pores; calcareous; strongly alkaline; pH 8.4 TB; abrupt wavy boundary.

C (5-40"); pale olive (5Y 6/3) silty clay, olive (5Y 4/3) moist; weak medium and fine subangular blocky structure; very hard, very firm, very sticky, plastic; common micro, very fine, and fine roots to 24 inches; common medium and course roots to 18 inches; few fine roots below; common very fine and fine pores to 30 inches, few below; calcareous; strongly alkaline; pH 8.8 TB.

Remarks: Cooperative range-soil study with the Range Department of University of Wyoming. This pedon was described at the Cumberland No. 1 exclosure.

HILLON loam (Cumberland Exclosure #2)
Soil Family: Ustic Torriorthent; fine-loamy, mixed, calcareous, frigid
Location: Lincoln County, Wyoming; section 7, T19N, R118W.
Climate: Mean annual precipitation for 14 years of record is 9.24 inches. Mean annual soil temperature is about 45°F and the frost-free season is about 100 days.
Vegetation: Big sagebrush, Rabbitbrush
Parent Material: medium textured, calcareous residuum
Topography: Slope-3 to 10 percent; elevation-6500 to 7200 ft.
Physiography: Pediment
Drainage: Well drained
Permeability: Moderate
Described by: C. Fowkes, 1971
(Colors are for dry unless otherwsie stated)

A1 (0-3"); light brownish gray (10YR 6/2) loam, dark grayish brown (10YR 4/2) moist; moderate fine granular structure; soft, very friable, sticky, plastic, many micro, very fine, and fine, common medium and coarse roots; calcareous; moderately alkaline; pH 8.2 TB; clear wavy boundary.

AC (3-16"); brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak medium prismatic parting to weak very fine subangular blocky structure; slightly hard, very friable, sticky, plastic; many micro, very fine, and fine, common medium and coarse roots; many micro, very fine, and fine pores; calcareous; moderately alkaline; pH 8.2 TB; clear wavy boundary.

C1ca (16-24"); pale brown (10YR 6/3) loam, brown (10YR 5/3) moist; massive; slightly hard, very friable, sticky, plastic; common micro, very fine, and fine roots; many micro, very fine, and fine pores; 5 percent channery; calcareous; fine soft concretions of calcium carbonate; moderately alkaline; pH 8.2 TB; gradual wavy boundary.

C2ca (24-31"); very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) moist; massive; soft, very friable, sticky, plastic; few micro, very fine, and fine, few medium and coarse roots; common fine pores; 5 percent channery; calcareous; fine soft concretions of calcium carbonate; moderately alkaline; pH 8.2 TB; gradual wavy boundary.

C3ca (31-42"); very pale brown (10YR 7/3) loam,pale brown (10YR 6/3) moist; massive; soft, very friable, sticky, plastic; few fine roots; moderate fine pores; 10 percent channery; calcareous; calcium carbonate mainly disseminated; strongly alkaline; pH 8.4 TB.

Remarks: Cooperative range-soil study with the Range Department of University of Wyoming. This pedon was described at the Cumberland No. 2 exclosure.

BINNA loam, moderately fine varient (Cumberland Exclosure #3)
Soil Family: Aridic Calciborolls; fine-loamy, mixed
Location: Lincoln County, Wyoming; section 32, T21N, R119W.
Climate: Mean annual precipitation for 15 years of record is 10.79 inches. Mean annual soil temperature is about 45°F and the frost-free season is about 100 days.
Vegetation: Big sagebrush, Bluegrass, Western wheatgrass, Bluebunch wheatgrass
Parent Material: Strongly calcareous, medium textured alluvium
Topography: Slope-6 to 10 percent; elevation-6700 ft.
Physiography: Alluvial fan
Drainage: Well drained
Permeability: Moderate
Described by: C. Fowkes, 1971
(Colors are for dry unless otherwsise stated)

A11 (0-3"); dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate very fine granular structure; soft, very friable, slightly sticky, slightly plastic; many micro, very fine, and fine, common medium and coarse roots; 10 percent gravel size coarse fragments; calcareous; moderately alkaline; pH 8.2 TB; clear wavy boundary.

A12 (3-8"); grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, very friable, slightly sticky, slightly plastic; many micro, very fine, and fine, common medium and coarse roots; few micro pores; 5 percent gravel size coarse fragments; calcareous; moderately alkaline; pH 8.2 TB; clear wavy boundary.

C1ca (8-13"); brown (10YR 5/3) loam, very dark grayish brown (10YR 3/3) moist; moderate fine subangular blocky structure; slightly hard, very friable, sticky, plastic; common roots all sizes; common fine pores; 5 percent gravel size coarse fragments; calcareous; thin lime coatings on coarse fragments; moderately alkaline; pH 8.2 TB; gradual wavy boundary.

C2ca (13-38"); very pale brown (10YR 8/3) loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, very friable, sticky, plastic; few fine roots; common micro, very fine, and few fine pores; 25 percent gravel size coarse fragments; calcareous; calcium carbonate mainly disseminated also as coatings on coarse fragments; strongly alkaline; pH 8.4 TB; gradual wavy boundary.

C3ca (38-45"); very pale brown (10YR 8/3) loam, yellowish brown (10YR 5/4) moist; massive; slightly hard, very friable, sticky, plastic; 25 percent gravel size coarse fragments; calcareous; calcium carbonate disseminated (5 percent less than above horizon); strongly alkaline; pH 8.4 TB.

Remarks: Cooperative range-soil study with Range Department of University of Wyoming. This pedon was described at the Cumberland No. 3 exclosure.

ELKOL (Cumberland Exclosure #4)
Soil Family: Ustic Torriorthent; fine, montmorillonitic, calcareous, frigid
Location: Uinta County, Wyoming; SW¼, section 22, T18N, R118W.
Climate: Mean annual precipitation for 13 years of record is 8.13 inches.
Vegetation: Gardner saltbush, Bottlebrush squirreltail
Parent Material: Alluvium
Topography: Slope-2 percent; elevation-6800 to 7200 ft.
Physiography: Alluvial fan
Drainage: Well drained
Permeability: Very slow
Sampled by: D. Lewis, J. Weinberg, and D. Trueblood
Described by: D. Lewis and J. Weinberg, 1979

A1 (0-5"); light gray (2.5Y 7/2) dry silty clay, grayish brown (2.5Y 5/2) moist; moderate fine granular structure; hard, friable, very sticky and very plastic; calcareous; strongly alkaline; pH 8.6; abrupt boundary.

C (5-60"); light gray (2.5Y 7/2) to light brownish gray (2.5Y 6/2) dry grayish brown (2.5Y 5/2) moist; weak medium subangular blocky structure; hard, very firm; very sticky and very plastic; calcareous, few threads and seams of calcium carbonate about 20" down and a few gypsum mycelia threads about 40" below the surface. Moderately to very strongly alkaline pH range 8.2-9.1; abrupt smooth boundary.

FARSON sandy loam, shale bedrock varient (Farson Exclosure)
Soil Family: Typic Haplargid; fine-loamy over sandy or sandy skeletal, mixed, frigid
Location: Sweetwater County, Wyoming; SE¼, NE¼, section 8, T25N, R106W.
Climate: Mean annual precipitation for 14 years of record is 6.47 inches. Mean annual soil temperature is about 45°F and the frost-free season is about 100 days.
Vegetation: Big sagebrush, Western wheatgrass, Needleandthread, Indian ricegrass
Parent Material: Thin, sandy and gravelly alluvium
Topography: Slope-0 to 6 percent; elevation-6590 ft.
Physiography: Terrace
Drainage: Well drained
Described by: C. Fowkes, 1971
(Colors are fpr dru unless otherwise stated)

A1 (0-3"); light brownish gray (10YR 6/2) sandy loam, dark grayish brown (10YR 4/2) moist; weak coarse platy parting to weak fine crumb structure; soft, very friable, slightly sticky, slightly plastic; many roots all sizes; 10 percent gravel sized coarse fragments, gravel paving on soil surface; noncalcareous; mildly alkaline; pH 7.4 PR; abrupt smooth boundary.

B2t (3-8"); brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; moderate medium prismatic structure parting to moderate coarse subangular blocky structure; hard, friable, sticky, plastic; many roots all sizes; many micro, very fine and fine pores; thin patchy wax-like coatings on all ped faces, clay bridging between sand grains; 10 percent gravel sized coarse fragments; noncalcareous; mildly alkaline; pH 7.6 PR; clear wavy boundary.

B3ca (8-12"); pale brown (10YR 6/3) gravelly sandy clay loam, brown (10YR 5/3) moist; weak coarse and medium subangular blocky structure; slightly hard, very friable, sticky, slightly plastic; few roots all sizes; 20 percent gravel sized coarse fragments; calcareous; secondary calcium carbonate occurs as fine soft concretions and as coatings on the undersides of the coarse fragments; strongly alkaline; pH 8.4 TB; clear wavy boundary.

II C1ca (12-32"); white (10YR 8/2) very gravelly loamy fine sand, light brownish gray (10YR 6/2) moist; massive; soft, very friable, nonsticky, nonplastic; few roots all sizes to 15"; 45 percent gravel sized coarse fragments; calcareous; calcium carbonate mainly disseminated and as coatings on the coarse fragments; strongly alkaline, pH 8.6 TB; clear wavy boundary

III C2 (32-40"); weathered soft grayish brown very strongly alkaline clay shale.

Remarks: Cooperative range-soil study with the Range Department of the University of Wyoming. This pedon was described at the Farson exclosure.

PIOMOSES (P) fine sandy loam (Radio Tower Exclosure)
Soil Family: Typic Camborthid; fine-loamy, mixed, frigid
Location: Sweetwater County, Wyoming; SE¼, NE¼, section 22, T19N, R103W.
Climate: Mean annual precipitation for 19 years of record is 7.40 inches. Mean annual air temperature is about 44°F, mean summer temperature is about 65°F, and the frost-free season is about 90 days.
Vegetation: Gardner saltbush, Big sagebrush, Indian ricegrass, Bottlebrush squirreltail
Parent Material: Residuum from shale, Baxter formation, with a surface layer of alluvium
Topography: Gently sloping, slope-2 percent, aspect-southeast; elevation-6800 ft.
Physiography: Upland pediment
Drainage: Well drained
Groundwater: Deep
Erosion: Slight
Permeability: Moderate
Sampled by: H. Ravenholt
Described by: H. Ravenholt, 7-13-79
(Colors are for air dry soil unless otherwise noted)

A1 0 to 4 cm. (0 to 1½ in.). Pale brown (10YR 6/3) fine sandy loam, brown (10YR 4/3) moist; weakly crusted, weak course platy structure parting to moderate very fine granular; slightly hard, very friable, slightly sticky, non plastic; strongly effervescent; ph 8.2 TB; clear wavy boundary.

IIB 4 to 23 cm. (1½ to 9 in.). Pale brown (10YR 6/3) loam, olive brown (2.5Y 4/4) moist; weak course prismatic structure parting to weak medium subangular blocky; hard, very friable, slightly sticky, plastic; strongly effervescent; pH 8.2 TB; common very fine to medium roots; gradual wavy boundary.

IIC1 23 to 38 cm. (9 to 15 in.). Light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/4) silty clay loam, dark grayish (2.5Y 4/2) and olive brown (2.5Y 4/4) moist; weak medium subangular blocky structure parting to weak very fine subangular blocky; slightly hard, very friable, very sticky, plastic, strongly effervescent; pH 8.4 TB; common very fine to medium roots; clear wavy boundary.

IIC2 38 to 66 cm. (15 to 26 in.). Light brownish gray (2.5Y 6/2) shaley loam, dark grayish brown (2.5Y 4/4) moist; 95 percent shale chips 1/16 to 1/8 inch thick by 1/8 to 1 inch in diameter that can be worked down to a loam; common very fine and fine roots; gradual wavy boundary.

IIIC3r 66+ cm. (26 in.). Fissile shale.

APPENDIX B

SOIL CHEMICAL ANALYSES

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LAB ANALYSIS FOR BLACK MOUNTAIN EXCLOSURE

ROOTING DEPTH 36"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A11	0-4	1	74	20	6	32.8	1.12	8.1	8.9	.6
A12	4-6	3	71	15	14	27.6	1.43	8.3	9.1	.5
B2	6-12	2	67	19	14	28.2	1.41	8.2	9.3	.7
B3ca	12-25	5	60	23	17	17.6	1.38	8.0	9.9	5.4
Clca	25-36	13	54	36	10	15.2	1.24	8.7	10.0	10.0

Horizon	Organic Matter (%)	CaCo$_3$ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A11	4.9	4.5	5.78	4.21	1.57	10.84	5.00	5.84
A12	1.4	4.0	9.09	6.52	2.57	12.50	7.02	5.48
B2	1.2	5.5	11.48	4.00	7.48	15.27	6.78	8.49
B3ca	1.2	7.5	16.29	9.06	7.23	28.32	10.34	17.98
Clca	1.2	11.0	21.99	12.26	9.73	26.26	6.58	19.68

LAB ANALYSIS FOR BOARS TUSK EXCLOSURE - RIDGETOP POSITION

ROOTING DEPTH 60"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-3	0	84	13	3	26.2	1.38	8.7	9.7	1.2
C1	3-19	1	82	15	3	23.6	1.51	8.8	9.2	.6
C2	19-36	2	81	12	7	15.4	1.41	8.5	9.0	.4
C3	36-60	12	90	6	4	10.0	1.70	8.7	9.5	.4

Horizon	Organic Matter (%)	CaCo$_3$ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	3.0	3.5	7.82	5.71	2.11	9.21	6.19	3.02
C1	1.3	3.0	6.20	4.23	1.97	3.90	2.29	1.61
C2	1.0	7.5	7.98	3.69	4.29	12.02	5.45	6.57
C3	.9	8.0	11.92	8.45	3.47	6.53	2.65	3.88

LAB ANALYSIS FOR BOARS TUSK EXCLOSURE - SWALE POSITION

ROOTING DEPTH 60"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A11	0-3	12	34	53	13	17.8	1.09	7.7	8.5	.7
A12	3-9	0	46	38	16	10.6	1.20	8.0	8.8	.5
C1	9-24	1	43	36	21	19.7	1.26	7.9	8.7	.5
k*	14-17	15	73	15	12	10.2	1.43	8.4	9.0	.4
C2	24-28	0	40	33	27	16.8	1.35	8.0	9.0	.9
C3	28-60	0	44	32	24	17.2	1.28	8.3	8.8	.6

Horizon	Organic Matter (%)	CaCo$_3$ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A11	6.1	17.5	13.74	8.82	4.92	17.93	9.01	8.92
A12	4.7	16.5	13.99	4.95	9.04	19.82	4.00	15.82
C1	2.4	23.1	20.12	8.51	11.61	20.25	8.04	12.21
k*	2.0	20.5	22.60	9.92	12.68	15.87	6.45	9.42
C2	1.5	17.5	13.27	7.17	6.10	23.42	9.68	13.74
C3	1.8	16.5	17.87	8.08	9.79	18.52	8.13	10.39

* -- Krotovina-not included in means

LAB ANALYSIS FOR CEDAR MOUNTAIN EXCLOSURE - ARSP TYPE

ROOTING DEPTH 7"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A11	0-1	28	53	35	12	22.0	1.61	7.9	8.8	1.0
A12	1-3	11	45	31	24	18.6	1.41	8.0	8.9	.6
B	3-7	6	41	37	22	16.0	1.43	8.0	8.9	.5
B3	7-30	23	41	28	31	12.0	1.66	8.1	9.1	.6
C1	30-46	29	48	26	26	14.6	1.55	8.1	8.8	.7

Horizon	Organic Matter (%)	$CaCo_3$ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A11	2.8	6.5	15.67	7.16	8.51	21.64	7.34	14.30
A12	2.8	5.0	12.50	9.69	2.81	23.01	9.16	13.85
B	2.9	6.5	23.98	18.79	5.19	20.00	9.35	10.65
B3	2.4	26.5	16.18	12.89	3.29	27.47	14.14	13.33
C1	2.0	21.0	9.92	5.19	4.73	23.89	10.20	13.69

LAB ANALYSIS FOR CEDAR MOUNTAIN EXCLOSURE - ARTR TYPE

ROOTING DEPTH 10"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A11	0-1	18	51	36	13	20.2	1.35	8.1	8.6	.6
A12	1-3	13	44	37	19	19.0	*	7.8	8.6	.6
B	3-10	19	25	54	21	17.6	1.29	7.7	8.6	.4
Clca	10-27	49	69	15	16	10.4	1.37	8.2	8.9	.4
IIC2ca	27-37	65	79	20	1	9.2	1.57	7.8	8.4	2.7
IIC3	37-50	65	87	12	1	6.8	1.46	8.1	8.2	2.5

Horizon	Organic Matter (%)	CaCo$_3$ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A11	3.5	9.5	12.58	4.94	7.64	18.54	7.14	11.40
A12	3.7	7.5	13.02	8.19	4.83	20.25	10.40	9.85
B	3.4	12.5	16.94	13.23	3.71	26.55	10.42	16.13
Clca	1.4	31.3	25.89	8.53	17.36	23.59	11.11	12.48
IIC2ca	.9	21.0	12.01	6.56	5.45	13.51	7.69	5.82
IIC3	.5	16.0	7.49	1.65	5.84	7.78	4.73	3.05

*-- Sample not available.

LAB ANALYSIS FOR CUMBERLAND EXCLOSURE #1

ROOTING DEPTH 40"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A11	0-2	0	24	46	30	9.2	1.29	7.8	8.3	.6
A12	2-5	0	29	37	34	12.2	1.32	7.8	8.5	.7
C	5-40	0	21	40	39	10.0	1.75	8.2	9.0	.9

Horizon	Organic Matter (%)	$CaCo_3$ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A11	2.6	13.0	23.66	12.30	11.36	30.37	10.27	20.10
A12	2.6	13.5	15.22	12.95	2.27	25.64	11.76	13.88
C	2.2	14.5	17.15	13.36	3.79	23.53	11.97	11.56

LAB ANALYSIS FOR CUMBERLAND EXCLOSURE #2

ROOTING DEPTH 42"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-3	10	42	42	16	11.2	1.20	7.7	8.4	.4
AC	3-16	6	40	42	18	11.0	1.22	7.8	8.4	.6
C1ca	16-24	5	35	40	25	8.2	1.28	7.7	8.5	.5
C2ca	24-31	6	32	40	28	8.8	1.41	8.1	8.6	.3
C3ca	31-42	6	36	41	23	9.4	1.30	7.9	8.6	.5

Horizon	Organic Matter (%)	$CaCo_3$ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	9.1	34.5	18.79	13.17	5.62	30.17	13.19	16.98
AC	3.9	39.5	19.27	14.71	4.56	28.27	10.47	17.80
C1ca	2.9	43.0	23.01	10.97	12.04	21.10	11.70	9.40
C2ca	2.7	47.0	21.29	12.69	8.60	29.81	11.63	18.18
C3ca	2.5	48.5	21.79	13.33	8.46	26.42	11.76	14.66

* -- Sample Not Available

LAB ANALYSIS FOR CUMBERLAND EXCLOSURE #3

ROOTING DEPTH 8"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A11	0-3	21	37	28	35	15.4	1.20	7.4	8.1	.5
A12	3-8	20	46	42	12	13.2	1.27	7.6	8.2	.5
C1ca	8-13	28	37	41	22	11.6	1.40	7.9	8.3	.5
C2ca	13-38	19	43	31	26	11.4	1.15	7.9	8.8	.5
C3ca	38-45	*	*	*	*	*	*	*	*	*

Horizon	Organic Matter (%)	$CaCo_3$ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A11	9.9	7.0	16.58	10.84	5.74	33.58	19.10	14.48
A12	6.7	12.5	19.63	14.82	4.81	29.55	16.52	13.03
C1ca	5.1	17.5	18.50	15.16	3.34	25.68	16.09	9.59
C2ca	1.9	51.5	26.86	11.81	15.05	33.56	13.58	19.98
C3ca	*	*	*	*	*	*	*	*

* -- Sample Not Available

LAB ANALYSIS FOR CUMBERLAND EXCLOSURE #4

ROOTING DEPTH 60"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-5	1	21	39	40	10.5	1.38	8.1	8.8	.4
C	5-60	0	23	56	21	12.8	1.52	8.1	8.7	7.3

Horizon	Organic Matter (%)	$CaCo_3$ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	1.6	12.1	16.18	7.88	8.30	23.77	9.75	14.02
C	1.7	11.7	16.43	12.44	3.99	22.41	11.42	10.99

LAB ANALYSIS FOR FARSON EXCLOSURE

ROOTING DEPTH 8"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-3	14	76	15	9	16.2	1.52	7.6	8.7	.4
B2t	3-8	10	69	10	21	11.4	1.51	7.6	8.3	.4
B3ca	8-12	64	71	15	14	10.4	1.07	7.6	8.5	.4
IIC1ca	12-32	54	71	15	14	7.2	1.38	8.2	8.9	.3
IIIC2	32-40	*	*	*	*	*	*	*	*	*

Horizon	Organic Matter (%)	CaCo$_3$ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	1.7	1.5	9.52	4.42	5.10	11.26	4.70	6.56
B2t	2.5	2.0	12.69	8.29	4.40	13.71	8.86	4.85
B3ca	2.3	18.0	11.49	7.98	3.51	14.86	9.72	5.14
IIC1ca	1.7	29.0	12.18	3.38	8.80	20.48	8.61	11.87
IIIC2	*	*	*	*	*	*	*	*

* -- Sample Not Available

LAB ANALYSIS FOR RADIO TOWER EXCLOSURE

ROOTING DEPTH 9"

Horizon	Depth (Inches)	Coarse (%)	Sand (%)	Silt (%)	Clay (%)	Very Fine Sand (%)	Bulk Density (g/cc)	pH		EC (mmhos)
								paste	1:5	
A1	0-1½	0	56	35	9	26.0	*	8.0	8.8	.9
IIB	1½-9	1	30	52	18	20.6	1.45	8.3	8.9	.6
IIC1	9-15	1	34	36	30	15.2	1.34	8.1	8.7	.4
IIC2	15-26	0	27	70	3	10.0	1.46	7.7	8.0	2.7

Horizon	Organic Matter (%)	CaCo$_3$ (%)	% Soil Moisture					
			Profile			Fines		
			1/3 bar	15 bar	Available	1/3 bar	15 bar	Available
A1	8.1	11.5	10.00	3.08	6.92	11.50	5.71	5.79
IIB	2.0	13.0	11.01	7.43	3.58	20.59	6.32	14.27
IIC1	2.3	18.5	19.55	9.87	9.68	18.32	7.07	11.25
IIC2	2.5	18.0	7.48	4.24	3.24	22.79	7.58	15.21

* -- Sample Not Available

APPENDIX C

PERCENT VEGETATIVE COVER

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PERCENT VEGETATIVE COVER
FOR
BLACK MOUNTAIN EXCLOSURE

YEARS

	1959	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS	10.6		8.3				15.9		
PERENNIAL GRASS	9.7		1.7				3.3		
ANNUAL GRASS	0		0				0		
PERENNIAL FORBS	.3		.3				.7		
ANNUAL FORBS	1.3		0				0		
TOTAL	21.9		10.3				19.9		

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS		12.2				13.0			12.0
PERENNIAL GRASS		8.6				5.4			5.7
ANNUAL GRASS		0				0			0
PERENNIAL FORBS		0				0			.3
ANNUAL FORBS		0				0			.3
TOTAL		20.8				18.4			18.3

PERCENT VEGETATIVE COVER
FOR
BOARS TUSK EXCLOSURE - SWALE POSITION

YEARS

	1961	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS	20.0		10.1				15.7		
PERENNIAL GRASS	21.4		6.2				5.3		
ANNUAL GRASS	0		0				0		
PERENNIAL FORBS	0		.2				.2		
ANNUAL FORBS	0		0				0		
TOTAL	41.4		16.5				21.2		

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS		12.5				15.2			14.7
PERENNIAL GRASS		6.9				8.9			9.7
ANNUAL GRASS		0				0			0
PERENNIAL FORBS		.4				.7			.3
ANNUAL FORBS		0				0			0
TOTAL		19.8				24.8			24.7

PERCENT VEGETATIVE COVER
FOR
CEDAR MOUNTAIN EXCLOSURE - ARSP TYPE

YEARS

	1959	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS	17.40		11.00				10.80		
PERENNIAL GRASS	0.00		1.40				1.80		
ANNUAL GRASS	0.00		0.00				0.00		
PERENNIAL FORBS	0.00		0.20				0.00		
ANNUAL FORBS	0.00		0.00				T		
TOTAL	17.40		12.60				12.60		

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS		18.00				10.20			13.50
PERENNIAL GRASS		4.00				7.40			2.90
ANNUAL GRASS		0.00				0.00			0.00
PERENNIAL FORBS		1.00				0.40			0.30
ANNUAL FORBS		0.00				0.00			0.00
TOTAL		23.00				18.00			16.70

T - Trace (<.1)

PERCENT VEGETATIVE COVER
FOR
CEDAR MOUNTAIN EXCLOSURE - ARTR TYPE

YEARS

	1959	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS	36.00		15.30				31.90		
PERENNIAL GRASS	0.70		1.30				0.70		
ANNUAL GRASS	0.00		0.00				0.00		
PERENNIAL FORBS	0.00		0.00				0.00		
ANNUAL FORBS	0.00		0.00				0.00		
TOTAL	36.70		16.60				32.60		

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS		27.30				23.20			26.70
PERENNIAL GRASS		0.30				0.00			0.60
ANNUAL GRASS		0.00				0.00			0.00
PERENNIAL FORBS		1.30				0.30			0.30
ANNUAL FORBS		0.00				0.00			0.00
TOTAL		28.90				23.50			27.60

PERCENT VEGETATIVE COVER
FOR
CUMBERLAND EXCLOSURE #1

YEARS

	1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS		18.58	9.06	24.23	12.30	13.91	20.20	16.70	15.50
PERENNIAL GRASS		1.75	2.33	2.18	2.86	2.73	2.70	1.20	3.18
ANNUAL GRASS		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS		0.00	0.30	0.25	1.50	0.13	0.00	T	T
ANNUAL FORBS		0.05	0.43	1.23	0.05	0.02	0.10	0.00	0.00
TOTAL		20.38	12.22	27.89	16.71	16.79	23.00	17.90	18.68

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS	16.00	15.22	19.85	16.60	23.80	8.90	7.19	27.02	16.57
PERENNIAL GRASS	2.52	0.77	4.60	1.61	1.57	3.84	0.62	2.28	2.30
ANNUAL GRASS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS	0.14	0.14	0.83	0.19	0.06	0.00	0.00	0.00	0.22
ANNUAL FORBS	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.17	0.13
TOTAL	18.70	16.15	25.28	18.40	25.43	12.74	7.81	29.47	19.22

T - Trace (<.01)

PERCENT VEGETATIVE COVER
FOR
CUMBERLAND EXCLOSURE # 2

YEARS

	1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS		12.91	14.05	13.35	20.33	11.76	7.10	10.40	17.45
PERENNIAL GRASS		1.46	3.63	4.60	3.01	3.69	2.80	3.80	6.79
ANNUAL GRASS		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS		3.36	0.03	9.63	1.76	4.19	2.85	2.18	1.11
ANNUAL FORBS		0.00	2.66	0.20	0.13	0.00	T	0.00	0.03
TOTAL		17.73	20.37	27.78	25.23	19.62	12.75	16.38	25.38

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS	17.60	10.39	24.15	16.05	*	3.76	1.43	7.03	12.52
PERENNIAL GRASS	2.13	2.04	3.52	1.51	*	5.08	4.09	2.30	3.36
ANNUAL GRASS	0.00	0.00	0.00	0.00	*	0.00	0.00	0.00	0.00
PERENNIAL FORBS	0.30	0.48	4.79	2.25	*	2.49	0.24	0.18	2.39
ANNUAL FORBS	0.05	0.04	0.00	0.35	*	0.00	0.00	0.03	0.23
TOTAL	20.08	12.95	32.46	20.16	*	11.33	5.76	9.54	18.50

T - Trace (<.01)   * - No Data Available

PERCENT VEGETATIVE COVER
FOR
CUMBERLAND EXCLOSURE # 3

YEARS

	1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS		29.81	32.65	19.43	29.03	5.91	22.30	16.30	17.00
PERENNIAL GRASS		1.09	2.29	5.38	3.66	4.02	4.40	4.40	3.76
ANNUAL GRASS		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS		1.14	0.05	2.91	3.31	1.05	2.20	0.30	5.54
ANNUAL FORBS		0.00	0.26	0.00	0.00	0.04	0.00	0.00	T
TOTAL		32.04	35.25	27.72	36.00	11.02	28.90	21.00	26.30

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS	13.04	12.89	23.33	26.25	11.80	22.85	14.11	16.39	19.57
PERENNIAL GRASS	2.05	1.77	2.53	0.89	1.80	2.94	2.93	2.11	2.88
ANNUAL GRASS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS	0.28	0.03	0.57	0.55	0.52	0.52	0.05	0.40	1.21
ANNUAL FORBS	0.24	0.05	0.00	0.68	0.13	0.20	0.00	0.04	0.10
TOTAL	15.61	14.74	26.43	28.37	14.25	26.51	17.09	18.94	23.76

T - Trace (<.01)

PERCENT VEGETATIVE COVER
FOR
CUMBERLAND EXCLOSURE # 4

YEARS

	1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS		16.10	8.20	9.80	8.58	4.48	5.90	1.70	26.75
PERENNIAL GRASS		0.09	0.08	0.20	0.73	0.46	0.40	0.30	2.95
ANNUAL GRASS		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS		0.00	0.00	0.15	6.83	3.80	7.90	10.30	T
ANNUAL FORBS		0.00	1.61	T	0.00	0.02	T	T	0.00
TOTAL		16.19	9.89	10.15	16.14	8.76	14.20	12.30	29.70

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS	18.13	7.06	9.52	12.56	11.05	2.90	2.75	10.14	9.73
PERENNIAL GRASS	3.40	3.34	4.60	0.86	0.63	3.25	0.03	0.56	1.37
ANNUAL GRASS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.81
ANNUAL FORBS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	.11	0.11
TOTAL	21.58	10.40	14.12	13.42	11.68	6.15	2.78	10.81	13.02

T - Trace (<.01)

PERCENT VEGETATIVE COVER
FOR
FARSON EXCLOSURE

YEARS

	1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS	13.33	10.72	8.30	11.10	14.65	9.78	11.40	13.80	10.20
PERENNIAL GRASS	0.21	2.27	2.80	1.80	1.61	1.68	1.50	0.80	1.81
ANNUAL GRASS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS	0.00	0.17	1.90	0.40	1.33	2.33	0.90	1.80	1.80
ANNUAL FORBS	0.00	0.00	0.00	0.10	0.00	0.04	T	0.00	0.00
TOTAL	13.54	13.16	13.00	13.40	17.59	13.83	13.80	16.40	13.81

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS	15.91	2.66	22.35	10.17	13.75	16.65	10.12	18.40	13.33
PERENNIAL GRASS	1.02	1.66	1.59	0.68	0.86	2.89	1.08	1.08	1.58
ANNUAL GRASS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS	0.02	T	0.00	0.00	0.05	0.05	0.00	0.01	0.67
ANNUAL FORBS	0.01	0.00	0.00	0.00	0.06	0.05	0.00	0.10	0.02
TOTAL	16.96	4.32	23.94	10.85	14.72	19.64	11.20	19.59	15.60

T - Trace (<.01)

PERCENT VEGETATIVE COVER
FOR
RADIO TOWER EXCLOSURE

YEARS

	1961	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS	26.8		15.8				17.6		
PERENNIAL GRASS	3.2		.4				2.2		
ANNUAL GRASS	0		0				0		
PERENNIAL FORBS	0		.1				.7		
ANNUAL FORBS	0		0				0		
TOTAL	30.0		16.3				20.5		

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS		21.0				22.3			20.7
PERENNIAL GRASS		2.3				3.8			2.4
ANNUAL GRASS		0				0			0
PERENNIAL FORBS		.8				.2			.4
ANNUAL FORBS		0				0			0
TOTAL		24.1				26.3			23.5

APPENDIX D

ANNUAL VEGETATIVE PRODUCTION

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ANNUAL PRODUCTION DATA
FOR
CUMBERLAND EXCLOSURE #1

YEARS

	1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS		*	*	*	*	*	*	*	*
PERENNIAL GRASS		31.30	204.24	226.51	270.99	345.79	230.98	184.27	104.19
ANNUAL GRASS		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS		0.00	*	*	1.82	11.71	0.00	0.00	0.00
ANNUAL FORBS		0.72	42.05	97.83	7.20	0.91	17.81	0.00	0.00
TOTAL		32.02	246.29	324.34	280.01	358.41	248.79	184.27	104.19

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS	664.14	366.91	362.62	280.15	408.34	175.98	187.24	331.86	347.16
PERENNIAL GRASS	167.05	193.46	169.55	363.82	279.79	181.98	74.47	164.89	199.58
ANNUAL GRASS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS	14.50	11.19	15.41	15.75	1.73	0.00	0.00	0.00	5.15
ANNUAL FORBS	1.73	0.38	0.00	0.00	0.00	0.00	0.00	52.91	13.85
TOTAL	847.42	571.94	547.58	659.72	689.86	357.96	261.71	549.66	565.74

* - No Data Available

ANNUAL PRODUCTION DATA
FOR
CUMBERLAND EXCLOSURE # 2

YEARS

	1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS		*	*	*	*	*	*	*	*
PERENNIAL GRASS		71.86	240.48	254.69	260.11	478.51	490.56	687.46	238.21
ANNUAL GRASS		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS		*	0.10	66.72	*	138.05	54.96	86.64	0.38
ANNUAL FORBS		0.00	31.58	9.36	2.54	0.00	2.40	0.00	0.53
TOTAL		71.86	272.16	330.67	262.65	616.56	548.02	774.10	239.12

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS	398.48	335.80	168.15	231.52	235.27	236.34	108.59	76.20	223.79
PERENNIAL GRASS	417.75	508.45	219.63	271.10	267.36	346.63	246.52	344.23	333.97
ANNUAL GRASS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS	45.90	66.07	66.79	55.80	75.48	78.22	7.35	21.85	54.59
ANNUAL FORBS	5.81	1.97	0.00	0.53	0.00	0.00	0.00	13.49	4.26
TOTAL	867.94	912.29	454.57	558.95	578.11	661.19	362.46	455.77	616.61

* - No Data Available

ANNUAL PRODUCTION DATA
FOR
CUMBERLAND EXCLOSURE # 3

YEARS

	1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS		*	*	*	*	*	*	*	*
PERENNIAL GRASS		82.32	157.40	210.96	231.55	344.22	477.89	291.31	140.74
ANNUAL GRASS		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS		*	3.84	18.00	*	37.78	66.24	16.42	0.14
ANNUAL FORBS		0.00	3.74	0.00	0.00	22.99	0.00	0.00	0.58
TOTAL		82.32	164.98	228.96	231.55	404.99	544.13	307.73	141.46

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS	490.13	522.91	247.14	979.72	414.64	313.51	231.15	440.30	454.94
PERENNIAL GRASS	183.86	219.44	137.66	169.02	318.45	162.11	142.61	255.02	220.29
ANNUAL GRASS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS	42.35	55.70	16.33	58.58	42.88	32.80	2.16	119.56	36.63
ANNUAL FORBS	114.86	4.90	0.00	35.44	12.39	23.91	0.00	2.40	13.83
TOTAL	831.20	802.23	401.13	1242.76	788.36	532.33	375.92	817.28	725.69

* - No Data Available

ANNUAL PRODUCTION DATA
FOR
CUMBERLAND EXCLOSURE # 4

YEARS

	1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS		*	*	*	*	136.71	192.73	19.73	156.63
PERENNIAL GRASS		1.56	1.15	21.79	78.53	47.00	51.41	74.01	174.16
ANNUAL GRASS		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS		0.00	0.00	75.84	*	*	*	1.78	0.00
ANNUAL FORBS		0.00	23.62	0.00	0.00	0.24	7.15	7.87	0.00
TOTAL		1.56	24.77	97.63	78.53	183.95	251.29	103.39	330.79

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS	430.05	37.54	12.13	314.66	365.65	93.29	32.81	307.30	174.94
PERENNIAL GRASS	259.44	263.18	152.50	171.08	158.65	165.61	2.02	73.08	105.95
ANNUAL GRASS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS	1.54	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.09
ANNUAL FORBS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	87.01	7.87
TOTAL	691.03	300.72	164.63	485.74	524.30	258.90	34.83	467.39	294.85

* - No Data Available

ANNUAL PRODUCTION DATA
FOR
FARSON EXCLOSURE

YEARS

	1962	1963	1964	1965	1966	1967	1968	1969	1970
SHRUBS	*	*	*	*	*	*	*	*	*
PERENNIAL GRASS	49.93	52.83	94.09	132.82	99.90	194.59	115.63	146.12	84.37
ANNUAL GRASS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS	0.00	*	*	*	*	22.90	4.87	10.79	9.31
ANNUAL FORBS	0.00	0.00	0.00	0.96	0.00	5.57	0.14	0.00	0.00
TOTAL	49.93	52.83	94.09	133.78	99.90	223.06	120.64	156.91	93.68

YEARS (CONTINUED)

	1971	1972	1973	1974	1975	1976	1977	1978	MEAN
SHRUBS	390.29	437.76	211.30	286.40	417.28	238.42	129.22	223.36	291.75
PERENNIAL GRASS	111.54	231.11	107.22	105.59	118.31	159.90	68.71	142.80	118.56
ANNUAL GRASS	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PERENNIAL FORBS	0.19	0.05	0.00	0.00	0.05	0.19	0.00	0.00	3.72
ANNUAL FORBS	0.10	0.00	0.00	0.00	2.40	0.77	0.00	4.08	0.82
TOTAL	502.12	668.92	318.52	391.99	538.04	399.28	197.93	370.24	414.85

* - No Data Available

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